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## *Looking to the Future*

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The concluding plenary session at the Sixth Annual National Agricultural Biotechnology Council Meeting was a panel presentation by representatives from four NABC member institutions: Iowa State University, The Ohio State University, University of Guelph and Rutgers, The State University of New Jersey. Each panelist discussed their impression of the NABC meeting from their perspective as a participant and what they as individuals expected to take away from the meeting. Their remarks seemed to express the feeling of many of the other attendees.

SPEAKER: PETER DAY

What did I learn? This was my first NABC meeting and I learned a great deal from it. Like many of you, perhaps, I approached the workshop sessions with mixed feelings. I had not met most of the individuals I was going to be talking with and knew little or nothing about them. I did not know what we were going to talk about and I was doubtful that we would have a product that was interesting. I was wrong. The conversations were sparkling and interesting. Once we got to know each other, there was a free exchange which emphasized to me what NABC is all about—open dialogue and listening to other people.

I congratulate our hosts on the structure they imposed on the workshops. The dynamics of the small groups were good, and the discussions went very well.

I am not going to discuss the workshop conclusions, but I would like to say a few things about the plenary sessions and the overall impressions that I am carrying away. We had two interesting and alluring perspectives, from Robert Fraley on food and feed products, and Ralph Hardy who emphasized non-feed, non-food products like human organs, oxygenated gasoline, and other exotic things that are around the corner. One area that was not mentioned in the non-food, non-feed area is the potential for biotechnology in environmental bioremediation. There was little mention of biotechnology applied to microorganisms other than means of combating them by engineering

resistance into host plants. Microorganisms are important. We tend to think only of the risk of released microorganisms and overlook the benefits that microorganisms afford in the environment and how we can do more with them.

Another thing I thought important, and Jim Cook focused our attention on it, was to stress that agricultural biotechnology is part of a continuum. I would put it in a slightly different way. In some respects agricultural biotechnology is like the icing on a cake; it is the most visible part of agricultural change and as a result the critics, with some justification, focus on it. But agricultural biotechnology is based on a continually changing system that we all too often take for granted. When we think of the perceived environmental threats of biotechnology we neglect the fact that agriculture has probably had the single greatest impact on the surface of the earth of any human activity. Agriculture's impact is often far from benign. I think of salinization from irrigation, soil erosion, slash and burn agriculture, and so on.

Biotechnology is like working with windows at a computer. You look at the window in front of you which is biotechnology. You forget that it is based on all the other systems that are not on the screen that we tend to take for granted. John Clark, an organic farmer, spoke to our workshop group in a very interesting and provocative way, but I am left wondering why, for example, given the concern for the Flavr Savr<sup>TM</sup> tomato, we did not give even a small amount of concern to broccoflower when it was first introduced. Those of you who are not familiar with broccoflower may recall that it is a hybrid between broccoli and cauliflower that hit the marketplace two or three years ago.

Another concern arises from Ralph Hardy's interesting account of Ogalala down. I guess your imaginations leapt, as mine did, at the idea of all of those millions of acres planted with milkweed. However, I venture to say that the impact of that unengineered crop planted even on a small fraction of the acreage that Ralph Hardy suggested would have a far greater impact environmentally than the introduction of, say, a mosaic virus-resistant tomato that had been engineered to express a viral-coat protein gene.

I do not want to discount the concern for the products of agricultural biotechnology in the recombinant DNA sense, but ask that we keep a sense of proportion and recognize that we are pounding a nail on the head. The head of the nail is agricultural biotechnology, and let us hope it is tough enough to take the pounding for the body of the nail is agriculture itself.

In the third plenary session, we heard about the opportunities for agricultural development in the developing world. Those opportunities are immense. I was particularly struck by John Dodds' example of a family unit producing 800,000 plant propagules. It was an example of Shoemaker's hypothesis set out in a book he wrote about 20 years ago, based on his experience in Africa, called *Small is Beautiful*. Jos6 de Souza Silva's equation—excess does not equal access—was memorable. Earlier in the meeting, Hope Shand had focused our attention on who is going to benefit from versus who will end up controlling biotechnology and the impact of this outcome on developing nations.

But perhaps the most important thing I am going to take with me is the need for dialogue and education. At Rutgers University we give a course for undergraduates on concepts and issues in biotechnology. One of the things we do is invite the students to play the parts that many of you ladies and gentlemen in the audience have taken at this meeting. Some are assigned roles as industrial scientists, regulators, city officials, outraged citizens, journalists and so on. We encourage them to argue, having provided them with magazine and newspaper articles to consider. It is enlightening, interesting and important. Also, it makes what might otherwise be a dry, esoteric subject come closer to home which is, after all, what NABC is all about.

SPEAKER: LARRY MILLIGAN

This has been my first opportunity to attend an NABC annual meeting. My comments reflect, to some considerable degree, my own individual experience at this particular meeting. First of all, I think that we are at a stage of development in biotechnology that allows for some issues to actually be bigger than life. At the beginning of new developments, anticipation often magnifies many aspects of what you think may be coming down the pipe. Often the anticipation of problems tends to make those problems look really big before they actually, if ever, appear. The anticipation of benefits easily leads to unrealistic expectations. At times, we need to stand back and say: Can we be a little more careful about assessing some of the realities? I think that needs to come out in some of our discourse. Some of the products and processes we are thinking of and some of those alluded to during the meeting really are not yet feasible. They are a very long ways off. We are going to have a long time to see the many intermediate steps with any problem happening and developing before we get these products to the consumer.

Another observation that I have is that we seem to assume a common definition of our topic, but actually we may not all be referring to the same concept. I think sometimes we are not. For example, I have found during the meeting that I am not really certain what is meant by the term "agricultural biotechnology." If we really mean biotechnologies encompassed in agriculture, then that is one thing. But I have encountered the connotation that agricultural biotechnology is genetic engineering, or at least entails only the techniques of molecular biology. This may be a narrower viewpoint than is appropriate. A number of biological technologies are extremely familiar in agriculture and have been around a long time. We will and do develop those technologies. Indeed, I suspect there will be a number of biological technologies with some genetic engineering element involved in them that we are going to soon see coming along and that we will accept them fairly readily. Chymosin, as Ralph Hardy pointed out, is an example of a product we have all encountered but we have heard little about. There are some products that just do not seem to impact on the feelings of people and we use them without much concern. There are others, however, that seem to more forcefully influence

our feelings. We have heard about a number of these during this meeting. If, in fact, there is some line of sensitivity within the breadth encompassed by agricultural biotechnology, I think there needs to be focus on that, and its understanding, in order to move ahead.

I suspect the issues that will come up about agricultural biotechnology will, as the future develops, become more focused on specific products and specific outcomes rather than more generally on the techniques of biotechnology as a whole. At the same time, however, I have detected issues at this meeting that may not be unique to agricultural biotechnology per se. With this modern set of tools, we now view some things as intellectual property that we might not have 10 or 15 years ago. Therefore, we have new problems of ethics, conflict and ownership to deal with. This is, however, an outcome of new capabilities rather than an issue limited to only agricultural biotechnology. I am not exactly sure which concerns underlie the feeling by some that agricultural biotechnology per se threatens biodiversity. I think we need to be more precise about what we mean and how we deal with issues.

One of the points that has come up during this meeting that impacts on me very directly and very personally is that of accountability to and understanding by a wider range of the public, particularly at the early stages of our research. I work at a publicly funded institution, and in the agricultural area we have more consultation about our directions in research than any other area of research in Canada. I think in large measure that is probably true in the U.S. as well. And yet, there remains a great deal of public concern about the adequacy of input into research directions and approaches! I think we need to reexamine the effectiveness of our consultation.

As a result of having attended this meeting, I wonder about the future directions of NABC. I have attained value as a result of my attendance, mostly because I was able to learn from, listen to and talk with people who have a range of views that I do not often get a chance to interact with—and that is very valuable. But in some ways it is a bit of a luxurious exercise. There were only about 200 of us here. How do we expand the circle? How do we create broader dialogue? Certainly, the Reports from NABC are extremely valuable to me and they need to be continued. I have also learned things that I will take home and will have an impact on what we do at the University of Guelph. And maybe in that fashion the circle is expanded. But there may be other steps that we could think about that would be effective. The experience of the workshops is important because that is where discussion happens. That is where we really exchange views. The need to come to recommendations in the workshops is a vehicle in and of itself that gets you to some point of saying “we can agree.” Otherwise, we would be inclined to procrastinate making any decision or showing any position. I do think it is important, though, that in the process of discussion we pay more attention to where those recommendations might go. Perhaps there can be greater influence (again expand the circle) by being sure that we have a place or target in mind for recommendations that come out of the meeting.

SPEAKER: BOBBY MOSER

As I approached this task of looking to the future, I tried to listen to all the workshop groups discussing the topics at hand and attempted to capture the most pertinent topics being discussed. Regardless of the workshop topic, each group came around to talking about some similar kinds of things. I heard discussions about the economics of biotechnology. Is it profitable? Is it economically feasible? I heard discussions about the environmental impacts of agricultural biotechnology. Then I heard discussions about the social impacts and acceptability of that technology as it reaches the marketplace and as it reaches the public. I found them quite interesting because, I believe, regardless of whether you are talking about agricultural biotechnology or all of agricultural research, in the future we will be asking ourselves those same three questions: Is it economically feasible? Is it environmentally sound? And is it socially acceptable? These three questions will prevail as we develop the technology. In the past in agricultural research, we focused some on environmental and social impacts, but mostly on the economic impacts. In the future we will focus more on the last two.

One of the areas of concern raised in all of the workshops was the need for public education and communication. I would like to focus on that in my comments, in terms of how I see what NABC, land-grant universities and colleges of agriculture can do as we look to the future in this particular area. Public education can be directed to a wide audience, from decisionmakers and legislators to the general public.

In terms of the decisionmakers, it is important that we make sure they have the scientifically-based information so that, as the policy decisions are made, they are made with factual information and not with emotions or opinions. Sometimes science does not prevail, as it should. It is important for us, as land-grant universities, colleges of agriculture or groups such as NABC, to make sure that those decisionmakers have the appropriate scientifically-based information at hand.

In terms of education, we have an obligation to try to educate everyone about this area called agricultural biotechnology. As scientists, this is our obligation. Currently, few scientists have public perception of their work on their minds as they develop and transfer genes from one plant to another, but I really think as we look to the future, this issue will become more important. We develop the technology that can be very environmentally sound and be used very efficiently and profitably in agriculture, but if the public does not accept that technology, it will never be used. So I believe public education is very critical to the future of agricultural biotechnology.

All of us at land-grant universities have a mechanism by which we can get this information out, and that is called our extension service. We should not overlook extension; they are dealing with the public on a day-to-day basis. Anytime something gets in the newspaper about bST (bovine somatotropin) or Flavr Savr™ tomatoes or whatever it might be, among the first people to get

telephone calls from the public are those in the County Extension offices. That just happened to us in our state, and I am sure in many of your states, with the above two issues. People call the county office asking the questions they have on their minds: Is it safe? Can I use it? How does it affect me? From farmers, questions of using that technology, bST: Is it profitable? Is it safe for the animals? Is it safe for the general public? From the general public asking: If I buy one of these tomatoes is it okay for me to eat it? Extension agents will get more questions directly from consumers than we will at the state level. We need to better use the Extension Service, an arm of our land-grant universities, as a way to facilitate public education. However, before we can do that, there may have to be a period of time when we educate the extension agents in this whole area of biotechnology so they feel comfortable answering those particular kinds of questions. Some of our institutions may need to develop some in-services for the extension agents to get them up to speed in this area so they can communicate intelligently about it. Also, we need more ways to get that information to trainers and teachers at all levels so they can incorporate it into their curricula. We, through NABC, can work together through extension and accomplish a great deal in this area.

It would be good if we had the available resources and information about biotechnology in some sort of a database that could be easily accessible. I do not know if that is feasible or not, but it would sure be great to have it available. With all the computer technology we have today, is that possible? I suspect that maybe it could be if we put our minds together and jointly developed a database that could be easily accessible, that really will address the kinds of questions the public is asking today about these particular issues.

Also, any material on biotechnology ought to be user-friendly. Scientifically-based, yes, but user-friendly, intended for the scientist as well as the non-scientist. What application does it have? How does it affect the real world? Often when we get into our research programs we deal with the science of the research and communicate with one another. But when we are talking to a nonscientist audience we lose the ability to communicate. That is where a lot of misunderstanding and controversy is created because the public does not understand and we, the scientists, have not really taken the time to communicate our science in a way that it can be understood. Development of fact sheets, like those used a lot in extension programs, are very important as a tool to communicate the whys of biotechnology and the ramifications that this technology might have. We need to make a point of working with high school teachers and junior high teachers to develop teacher guides to be used in their science classes. They may know about biotechnology in some ways, but do they know enough to be able to really develop a curriculum to be used in their classes? We need to build on what some have already started.

We need to target audiences such as teachers or extension agents or general consumers and find a way for them to easily access this particular database that we develop. At some point, they can start entering questions they

might have. When those public questions come in they can be put into the database and answers provided.

Another important point is to establish an ongoing linkage or communication with extension agents and with teachers, with teachers of teachers, and with other information people. I think that is important, especially as we deal with current issues. Most recently, the most controversial issue we have had is probably bST, an issue everyone knew was coming at some point. We were getting questions from our extension agents asking, "How can you help us, because we know the questions are coming soon?" Our people put together a packet of information that went out to all of our county agents, where it was used very effectively. They felt comfortable about addressing questions because of this information we developed for them. We need to anticipate some of those kinds of questions and be able to develop a set of information that can be used by the nonscientist educator, such as an extension agent or teacher. An ongoing communication or linkage, a newsletter type of approach coming out from the research base, the experiment station, to the extension program could be very important in this regard.

Basically, the purpose is to have a public more literate about biotechnology. Biotechnology needs to become a part of the science that students learn in school science courses, just like protein synthesis is an accepted technology discussed widely in science classes. Biotechnology should receive that same kind of discussion and be met with the same acceptance by teachers who teach that technology in their classes. These goals, to me, are just raising the level of people's knowledge about this area and would help to diffuse some of the controversy. We will still have discussions about issues, but people will understand better why we are doing the things we are doing and why these particular technologies are going in the direction in which they are. That may be a little different charge than what some people might think is important for this organization (NABC), but, for me, it is a critical one. As I listened to the discussions, public education and understanding, or lack of understanding, or misunderstanding of biotechnology surfaced in every discussion. It is one we need to address now.

SPEAKER: PATRICIA SWAN

How many times in life would you like to be given the official last word on a subject? Often this is an enviable position, but after two days of thoughtful commentary, it is not a particularly enviable position to be in today.

This is my fourth NABC meeting, so I have tried to listen and think about trends in these conferences over the last few years. One thing is very different today as compared to four years ago. Today we are seeing products of genetic engineering and modern biotechnology techniques already being applied in the food and agriculture system. Four years ago there was much more focus on questions as to whether these techniques would be used. Could they be used? Should they be used? That is, a focus on very preliminary kinds of questions.

In this year's meeting, there was much less emphasis on speculation as to use of biotechnology. Instead, we have begun to emphasize different topics, ones that were mentioned four years ago but which have now become more important to us. They are topics that arise out of the experience we now have with products of modern biology applied to food and agriculture. First, as Larry Milligan pointed out, with our greater experience we now are dealing with biotechnology as a part of the general modern biological science approach to living systems rather than as a unique and separate set of technologies. We have accepted biotechnology as part of modern science, just part of the array of tools that we have for developing our food and agriculture system.

I want to emphasize four meeting themes that I have identified as ones receiving increased emphasis, as compared to four years ago. The first theme is that of access to the technology. Who will get it and where? Who is getting it? Are they getting it? These are much more immediate kinds of questions.

The second theme, that of rights to biological materials, is becoming dominant in our conversation. Sure, we talked about these rights four years ago but not with the same degree of urgency that we are talking about them today. Many factors account for that change, but the result is that rights to biological materials have become a much bigger issue for us.

The third theme is that of the integration of social, economic and environmental issues with the technical issues surrounding biotechnology. We spent a lot of time talking about social, economic and environmental impacts four years ago, but we discussed them as very separate issues. We talked about the "fourth criterion" as being separate from the other three. At this conference those issues were much more integrated into conversations about all aspects of agricultural research and development than they were four years ago.

Fourth, in addition to access rights and impacts, the concern for public participation is growing, and I suggest that our frustration over how to accomplish it is growing also. At this meeting we have again identified the need to make information available to all, to make education programs available to all, and to recognize the need for mechanisms for public participation in the very early stages of research and development decisions. But we need more good ideas about how to do this. We exhort more than we actually are able to design effective ways to gain public participation.

Finally, one overall trend in this meeting, from the very first session through the last session, has been the broadening of our concept of the agriculture sector. We were much more narrowly focused on agriculture production and to a lesser extent on food processing four years ago. Now we are thinking of a much broader kind of enterprise when we talk about the food and agriculture system. We are talking about industrial uses of agricultural resources (land, water, labor, capital) which once were deployed solely for food and feed and, to a minor extent, fiber production. We are now anticipating that more of those resources will be used for production of industrial products ranging from new materials, to fuels, to pharmaceuticals. This is a rather new idea,



and a much broader set of issues about choices arises out of it. These new issues are, in part, what lead us to emphasize the need for broader public participation as well as the need for broader public support for research and development aimed at making the best use of resources in the food and agriculture system.

The real challenge to us all is: How shall the public sector (as defined by individuals, as defined by advocacy groups, as defined by land-grant universities and all the very many parts that make up the public sector) participate with the private sector in all its many parts as we look toward developments in the future? How will we assure that developments in this very broadly defined food and agriculture sector will be for the public good? This is a tremendous challenge for NABC and for us all.